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ABSTRACT

This report describes a program that enhanced vocabulary development and communication within the content area of mathematics. The targeted population was a rural K-12 school district located in the Midwest approximately an hour from three major metropolitan cities. Evidence for the existence of the problem included teachers' observation, Arithmetic Done Daily (ADD), class discussion, assessment of mathematics performance, and journal entries. Information gathered suggested that the students were lacking the understanding of content vocabulary for mathematics, and therefore had poor communications skills that lead to unsuccessful communication of their mathematical understanding of a problem and its probable answer. The interventions used were many of the same strategies used by teachers to teach vocabulary in reading and any other content area rich in vocabulary. These strategies included vocabulary journals, math journals, vocabulary word wall, and Multiple Intelligence strategies that would try to reach all learners. The textbook series that the school district adopted had a wealth of activities that developed and built an understanding of the language used in math. Post intervention data showed an increase in understanding and use of mathematical vocabulary in math performance and in communication of mathematical issues. All students who participated in the study increased their vocabulary knowledge level in the area of mathematics vocabulary. (Contains 58 references.) (Author/ASK)

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VOCABULARY AND ITS EFFECTS ON MATHEMATICS INSTRUCTION

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This report describes a program that enhanced vocabulary development and communication within the content area of mathematics. The targeted population was a rural K-12 school district located in the Midwest approximately an hour from three major metropolitan cities. Evidence for the existence of the problem included teachers' observation, Arithmetic Done Daily (ADD), class discussion, assessment of mathematics performance, and journal entries. Information gathered suggested that the students were lacking the understanding of content vocabulary for mathematics, and therefore had poor communications skills that lead to unsuccessful communication of their mathematical understanding of a problem and its probable answer.

The interventions used were many of the same strategies used by teachers to teach vocabulary in reading and any other content area rich in vocabulary. These strategies included vocabulary journals, math journals, vocabulary word wall, and Multiple Intelligence strategies that would try to reach all learners. The textbook series that the school district adopted had a wealth of activities that developed and built an understanding of the language used in math.

Post intervention data showed an increase in understanding and use of mathematical vocabulary in math performance and in communication of mathematical issues. All students who participated in the study increased their vocabulary knowledge level in the area of mathematics vocabulary.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted fifth grade class exhibited poor understanding of content vocabulary for mathematics. This interfered with communication of mathematical issues and academic growth. Evidence for the existence of the problem included teacher observations, Arithmetic Done Daily (ADD), class discussion, and assessment of math performance.

Description of Immediate Problem Context

The fifth grade class was part of a small unit district that consisted of two schools. The building site for this study houses Pre-kindergarten through fifth grades. This building was built in 1968. The other building in the district was built in 1924 and houses grades sixth through twelfth. The school district is located in a rural area in the Midwest approximately an hour from any one of three large metropolitan cities.

At the time of the study enrollment for the elementary school totaled 252 students, of which 97.2 percent were Caucasian, 0.4 percent African-American, 2.0 percent Hispanic, and 0.4 percent Asian/Pacific Islander. Students enrolled who came from families that received public aid, lived in foster homes with public funds, or were eligible to receive free or reduced-price lunch totaled 11.5 percent. The school reported an

attendance rate of 96.4 percent. Chronic truancy was not reported as an issue. Student mobility was 29.5 percent.

The certified elementary teaching staff was made up of 100 percent Caucasian. The elementary teaching staff consists of 6.3 percent male and 93.4 percent female. Thirty-eight percent of the certified staff held a master's degree or higher. The average teaching experience in the elementary school was 13.4 years. The student-teacher ration was 17.0:1.

The elementary school offered special education services to seven percent of the student population. Special education services included Individual Learning Program (ILP), speech, occupational therapy, vision and hearing, social work, and psychological services. Other services were available through a special education co-op.

The Individual Learning Program was designed to help those with a learning disability. Six components were used to identify those who qualified for placement in ILP. To receive ILP services a student needed to demonstrate a delay in academic achievement. Teachers' observations of daily classroom performance, such as work samples, quizzes and tests, and textbook publisher placement and mastery tests documented this. In addition tests like the Wechler Intelligence Scale for Children-Revised helped determine if a student exhibited at least average intellectual ability and that learning was not due to mental retardation. A key factor to ILP placement was if there was evidence that there was a severe discrepancy between student's ability and achievement for his/her ability. (Learning Disability Guidelines, 1998)

The elementary school provided transitional first and second grades. The transitional program was formed to ensure that learning situations were appropriate to

pupil's general ability, maturation, and achievement. The transitional curriculum included tasks appropriate to the student's abilities with clear expectations for student performance. A student was placed at the appropriate level after the staff reviewed overall daily performance (report cards), local assessments, achievement scores (Stanford Achievement Test), and physical and emotional maturity.

Title One was available to the school to service about 10 percent of the student population in the area of reading. Title One placement was determined by state and local assessments, and other assessment tools such as, Woodcock Reading Mastery Test. These were used to help identify a student's functioning level, and create a database of before and after scores in regards to the remediation program.

In 1996 students from six rural communities came together to form a rural district. This was due to population growth. Prior to that time boundary lines of newly developed subdivisions cross multiple education/school districts. Population of community A was 1,581. Ninety-two percent of the population was Caucasian, 0.11 percent were African-American, 0.33 percent were Asian/Pacific Islander, 0.09 percent were Native American, and 7.18 percent were of other races. The median family income was $37,722. The population made up of individuals 25 years and older and held less than a ninth grade education was 11.18 percent, 13.16 percent finished ninth to twelfth grade with no diploma, 40.21 percent graduated High School or the equivalent, 18.18 percent had some college, but no college degree, 4.30 percent earned an associate degree, 9.27 percent had a Bachelor's degree, and 3.75 percent had a Graduate or professional degree.

Population of community B was 8,450. Ninety-eight percent of the population was Caucasian, 0.21 percent were African-American, 1.21 percent were Asian/Pacific

Islander, 0.08 percent were Native American, and .86 percent were of other races. The median family income was $39,893. The population made up of individuals 25 years and older and held less than a ninth grade education was 6.93 percent, 13.71 percent finished ninth to twelfth grade with no diploma, 36.61 percent graduated High School or the equivalent, 27.84 percent had some college, but no college degree, 4.92 percent earned an associate degree, 6.55 percent had a Bachelor's degree, and 3.44 percent had a Graduate or professional degree.

Population of community C was 1,849. Ninety-eight percent of the population was Caucasian, 0.00 percent were African-American, 0.54 percent were Asian/Pacific Islander, 0.04 percent were Native American, and 1.51 percent were of other races. The median family income was $45,610. The population made up of individuals 25 years and older and held less than a ninth grade education was 8.38 percent, 16.48 percent finished ninth to twelfth grade with no diploma, 39.23 percent graduated High School or the equivalent, 20.07 percent had some college, but no college degree, 4.05 percent earned an associate degree, 8.38 percent had a Bachelor's degree, and 3.41 percent had a Graduate or professional degree.

Population of community D was 2,686. Ninety-nine percent of the population was Caucasian, 0.19 percent were African-American, 0.00 percent were Asian/Pacific Islander, 0.52 percent were Native American, and 0.00 percent were of other races. The median family income was $48,368. The population made up of individuals 25 years and older and held less than a ninth grade education was 3.88 percent, 10.22 percent finished ninth to twelfth grade with no diploma, 26.62 percent graduated High School or the equivalent, 25.06 percent had some college, but no college degree, 5.64 percent earned an

associate degree, 9.76 percent had a Bachelor's degree, and 4.73 percent had a Graduate or professional degree.

Population of community E was 1,415. Ninety-eight percent of the population was Caucasian, 0.42 percent were African-American, 0.00 percent were Asian/Pacific Islander, 0.00 percent were Native American, and 1.84 percent were of other races. The median family income was $39,792. The population made up of individuals 25 years and older and held less than a ninth grade education was 11.20 percent, 11.42 percent finished to twelfth grade with no diploma, 35.39 percent graduated High School or the equivalent, 24.30 percent had some college, but no college degree, 1.90 percent earned an associate degree, 11.65 percent had a Bachelor's degree, and 4.14 percent had a Graduate or professional degree.

Population of community F was 1,581. Ninety ninth -nine percent of the population was Caucasian, 0.25 percent were African-American, 0.00 percent were Asian/Pacific Islander, 0.00 percent were Native American, and .19 percent were of other races. The median family income was $39,400. The population made up of individuals 25 years and older and held less than a ninth grade education was 6.25 percent, 15.77 percent finished ninth to twelfth grade with no diploma, 35.96 percent graduated High School or the equivalent, 27.60 percent had some college, but no college degree, 4.23 percent earned an associate degree, 7.21 percent had a Bachelor's degree, and 2.98 percent had a Graduate or professional degree. (See Tables One and Two)

Table 1

Communities' Population and Median Family Income

Community	Population	Percent Caucasian	Percent African-American	Percent Asian	Percent Native American	Percent Other Races	Median Family Income
A	10,633	92.29	0.11	0.33	0.09	7.18	$37,722
B	8,450	97.63	0.21	1.21	0.08	0.86	$39,893
C	1,849	97.51	0	0.54	0.04	1.51	$45,610
D	2,686	99.29	0.19	0	0.52	0	$48,368
E	1,415	98	0.42	0	0	1.84	$39,792
F	1,581	99.56	0.25	0	0	0.19	$39,400

Table 2

Percent of Population 25 Years and Older Educational Attainment

Community	Less than Ninth Grade	Ninth to Twelfth Grade-No Diploma	High School Graduate or Equivalent	Some College-No Degree	Associative Degree	Bachelor Degree	Graduate or Professional Degree
A	11.18	13.16	40.21	18.18	4.30	9.27	3.75
B	6.93	13.71	36.61	27.84	4.92	6.55	3.44
C	8.38	16.48	39.23	20.07	4.05	8.38	3.41
D	3.88	10.22	26.62	25.06	5.64	9.76	4.73
E	11.20	11.42	35.39	24.30	1.90	11.65	4.14
F	6.25	15.77	35.96	27.60	4.23	7.21	2.98

NATIONAL CONTEXT

Seventy-five percent of the adults in the United States have experienced anxiety towards mathematics. (Wahl, Mark 1997) These adults most likely experienced

anxiety in elementary school and as they got older the anxiety only intensified. These adults have often experienced sweating palms, mind going blank, or simple avoidance of all activities where mathematics was involved. If our adults experienced such anxieties over mathematics there is a high probability that in our classrooms we have students that are experiencing the same types of anxieties. "Cases of anxiety will usually be even more pronounced each grade from four through seven and beyond than in primary grades." (Wahl, 1997, p. 47) Why are so many students feeling anxiety towards mathematics and how do we break the cycle? How do we create an atmosphere where students feel comfortable enough to trust his/her teacher, his/her classmates, his/her abilities to do well in school, and relax enough and enjoy the education they are receiving? This individual anxiety towards mathematics may have interfered with national scores that have been gathered.

As a nation we are not doing well compared to other countries in the area of mathematics. The Second International Assessment of Educational Progress (IAEP) found that nine year olds from the United States scored lower, on average, than peers in five other large countries. Thirteen-year-olds didn't do much better against their peers. Their results suggest that thirteen year olds in the United States may even be performing two to three years below their peers in Korea. (Educational Testing Services, 1992)

Several years later the United States participated in the Third International Mathematical and Science Study (TIMSS). This was the most comprehensive worldwide study of student achievement of its time. It included an international curriculum analysis to ensure that the test reflected what was covered in mathematics courses taught in participating countries. TIMSS, also, collected information through questionnaires

administered to teachers, students, and school administrators. A comparison was done on mathematics textbooks, and mathematics instruction was even videotaped in several countries. The goal was to develop a test that tested material that was taught in the majority of countries and not overemphasize material that was taught in only a few, and to provide a detailed case study of educational policies.

The test was given to 500,000 students in 40 countries. Again American students scored near the bottom. (Hiraoka, Leona, 1998) Our best scores for eighth grader in the United States was similar to scores of average students in Singapore. Twenty out of forty countries outperformed the United States at the eighth grade level. Mathematics classes in the United States were found to be less advanced and less focused. United State's eighth graders cover content that is usually presented to seventh graders in many other countries. American eighth graders are taught general arithmetic (fractions, decimals, computational skills, etc.), and grouped by ability. Other countries were found to have placed heavy emphasis on algebra and geometry for all students in eighth grade. The videotapes of math classrooms showed that teachers in the United States try to cover so much material that it does not allow students enough time to develop an in-depth understanding of the concepts. This overload on topics was apparent in the United States' textbooks, as well. (National Education Goals Panel, 1997)

Another study done by two psychologist, David S. Crystal and Harold W. Stevenson found that parents of United States grade schoolers hold lower standards for math achievement than do parents in Japan or Taiwan. Parents in the United States were found to have provided less math assistance than parents in these other two countries do.

The same was found to be true for siblings assisting the grade schoolers (Science News, 1991).

Even in our own country our students are not meeting expectations. In 1990, only 12 to 15 percent of fourth, eighth, and twelfth graders met the criteria set on a nationally administered United States achievement test, the National Assessment of Educational Progress (NAEP). The Secretary's Commission on Achieving Necessary Skills (SCANS) through the United States of Labor estimates that less than half of all young adults have achieved reading and writing minimums. However, even less were able to reach minimum in mathematics. (SCANS 2000, 1991) Basic Skills today and in the future need to be far more than computational proficient. The technical skills of a country's workforce are crucial to its economic competitiveness. The students of today will be tomorrow's workers, and they will need to depend on the mathematics learned now to succeed and be competitive in the future.

CHAPTER 2

PROBLEM DOCUMENTATION

PROBLEM EVIDENCE

Mathematics has a large, subject specific vocabulary that needs to be mastered if the ideas in mathematics are to be transmitted quickly, efficiently, and accurately. It is crucial to emphasize vocabulary instruction as part of a mathematics program. Professor Wayne Esty states that mathematics has its own grammar, syntax, vocabulary, word order, synonyms, negatations, conventions, idioms, abbreviations, sentence structure, and paragraph structure. (1992) Once students are taught to recognize patterns they will find mathematics far more comprehensible than those who are not taught the patterns. There is little evidence that classroom teachers teach content vocabulary as it relates to mathematics and mathematics textbooks fail to describe mathematical concepts adequately.

A variety of tools were used to show evidence that the targeted fifth grade students exhibited poor understanding of content vocabulary in the area of mathematics. The tools used included vocabulary pretest, student surveys, parent surveys, teacher observation, and district's adopted Arithmetic Done Daily (ADD) program that supports mathematics skills.

The study utilized a control group and a non-control group. The teacher/researcher was the primary/homeroom teacher for the control group. The non-control group fifth grade students and teacher were in the same building as the control group.

Vocabulary Pretest

A review of the literature would indicate that vocabulary receives little attention from the teachers of mathematics. Experts, Eula Ewing and Robert Panchysyn have found that mathematical material is hard to read with more concepts per word, per sentence, per paragraph than any other content area. They feel it is crucial to emphasize vocabulary instruction during mathematics instruction. (1998) Textbooks fail to describe mathematical concepts and curriculum seems to be a mile wide and an inch deep with little in-depth understanding making teaching material more difficult. (National GoalsPanel,1997) Other experts have found that traditional teachers to be "drill masters" and unable to relate mathematics to applied problems.

A vocabulary pretest was designed to measure the students' prior level of knowledge of mathematics content vocabulary in the targeted fifth grade. (Appendix A) The utilized mathematics textbook provided a list of vocabulary words. The teacher/researcher added to the list and as a result a combination of 126 words were found in the classroom textbook that would to be introduced and taught during the research period. (Appendix B) These words were selected because of their multiple usage in the text and their importance to understanding key concepts in mathematics.

The pretest focused on the individual math content vocabulary and the definition of each word. The words were arranged in alphabetical order, so that there would be

limited word associations. The pretest was administered over five days. Each day for four days the students were tested over 26 words. On the fifth day the students were tested over the last 22 words. The students were required to match a vocabulary word to its correct definition.

An analysis of the control group students' responses showed that the students were familiar on average with 27% of the vocabulary that would be presented throughout the school year in mathematics. The students in the control group were able to identify approximately 26 of the 126 words tested. The non-control group scored on average 28%. The control group scored on average 35 of the 126 words tested.

Student's Survey

Research shows that there may be several underlying causes for poor achievement and high discomfort in the area of mathematics. Experts have found that some students have no confidence in their abilities, and try to do as little mathematics as possible. This in the end inhibits their future success in mathematics. Anxiety needs to be addressed in the classroom; however, standards should not be lowered. Students need to feel that they have accomplished meaningful tasks, and by lowering expectations only convinces students they do not have what it takes to be successful in the mastery of mathematics. Students may not trust their thinking skills or build their math confidence. (Diana F. Steele and Alfred A. Arth, 1998)

The teacher/researcher was concerned about the anxiety students had toward mathematics. To determine this the students in the study were administered a survey developed by Mark Wahl from his book Math for Humans. (Appendix C) During the third week of school the students completed a ten-question survey that was used to

identify their anxiety level towards mathematics. The students were required to read a question and rate the statement on a likert scale from one to five. One being almost never true, or have little feeling about and five being always true, or you have a strong emotional reaction.

Questions four, six, eight, nine, and ten were targeted for deeper analysis for this study. These targeted five questions dealt specifically with mental and physical reactions towards mathematics. The other questions dealt primarily with attitudes towards people that do well in or like mathematics. The teacher/researcher for this study is primarily concerned with the attitudes students have towards themselves when it comes to mathematics and students' attitude towards the subject area of mathematics.

The survey revealed that the targeted fifth grade control group on average scored a 24. Eleven of the students in the control group who took the survey gave themselves at least one score of four or five. This seems to indicate that 55% of these particular students have some strong feelings and/or strong emotional reactions towards mathematics.

The non-control group on average scored a 21 on the mathematic's survey. Four students who took the survey gave themselves at least one statement a four or five. This particular group of students did not have as strong of discomfort or anxiety when it came to mathematics. Only 21% percent of the students felt strong about any statement on the survey.

Parents' Survey

A student whose parents show an interest in and enthusiasm for mathematics would more likely develop enthusiasm for mathematics compared to a student whose parents are indifferent when it comes to mathematics. Studies have shown that parents' participation in students' homework can increase achievement. (Martin D. Hartog, Patricia Brosnan, 1994)

During the fourth week of school the parents of the control and non-control groups were surveyed to identify their anxiety level towards mathematics. The parents were given the same survey as the students. (Appendix C) The teacher/researcher wanted to see if there was any correlation between a parent's attitude towards mathematics and the students'.

The parents' survey showed that the average score was 12 points. Only four parents expressed any discomfort and/or anxiety towards mathematics. The majority of parents felt very confident. One parent even remarked that they enjoyed mathematics and felt that a little anxiety when it comes to mathematics is good for performance. Yet, another parent expressed that she felt very uncomfortable taking the survey. She felt embarrassed that her child or anyone else might learn that she felt inadequate when it came to mathematics.

Teacher's Observation

The United States Department of Education believes that linking concepts to one part of a lesson to ideas or activities in another part of the lesson is believed to improve students' abilities to learn and become more literate in a content area. Diane F. Steele and Alfred A. Arth in their article Lowering anxiety in the math curriculum state that the

National Council of Teachers' of Mathematics (NCTM) has set five goals that would help enhance students' mathematics literacy. These five goals are:

1. Learn to value mathematics
2. Become confident in own mathematics ability
3. Become a mathematics problem-solver
4. Learn to communicate mathematically
5. Learn to reason mathematically

The NCTM believes that future success in mathematics is dependent on math literacy. They also believe that students are not being allowed to openly express their attitudes and feelings about mathematics. (1989)

The teacher/researcher developed a checklist that she used to identify verbal and nonverbal signs of students' attitudes towards mathematics, and correct vocabulary usage. (Appendix D) The teacher/researcher used the checklist during mathematics instruction and after instruction to aid her in collecting data that may show patterns, problem areas, and attitudes towards mathematics. The teacher/researcher found that the students showed many negative nonverbal and negative verbal cues. Their use of proper mathematics vocabulary was poor to none. Transfer of mathematics concepts and ideas were poor.

Arithmetic Done Daily

The teacher/researcher used Arithmetic Done Daily (ADD) on a weekly basis to enrich and review mathematical operations. (APPENDIX E) ADD is part of the required curricular materials to be used in the teacher/researcher's school district. ADD is a comprehensive mathematics review program that provides needed exposure and review

for students through short, daily mathematics exercises. (GROW Publications, 1998) The students in the targeted fifth grade were required to complete three pages from their ADD booklet each week. Each Friday students and the teacher/researcher would go over the problems that were assigned for the week. The teacher/researcher found that the students were not meeting much success in completion of these pages. The students were not completing the pages and many students stated that they couldn't always understand the instructions given.

Probable Cause

The causes for students' lack of understanding of mathematical vocabulary are many and varied. Research literature and site-based studies both indicate that the probable causes may be because the textbooks are using technical language, students view mathematics as dull and boring, students lack basic knowledge of vocabulary in mathematics, students never had to communicate in mathematics before, students have math anxiety, and parents may be lacking in mathematics skills or poor attitude towards mathematics. These will be the areas that the teacher/researcher will target to improve understanding of vocabulary in mathematics.

CHAPTER 3

THE SOLUTION STRATEGY

LITERATURE REVIEW

A review of the literature on the poor understanding of content vocabulary for mathematics, and how this interfered with communication of mathematical issues and academic growth revealed various solutions. Key components to improve math content, vocabulary awareness, understanding, and further growth in mathematics education are varied. Mathematics curriculum needs to focus more on content vocabulary and its usefulness to communicate mathematically through both written and oral means. (National Council of Teachers of Mathematics, 1998) There is a need to focus on open-ended problem-solving problems. The use of manipulatives, time to develop multiple intelligence activities, and cooperative groups for exploration and discovery need to be implemented. Writing to facilitate understanding of math concepts that supports math strategies and fosters complex thinking need to be used. Monitoring anxiety towards mathematics is also a component that needs to be put into practice.

Mathematics provide students with opportunities to grow in the ability to read write and talk about situations involving numbers, variables, equations, figures and graphs. (Illinois Learning Standard for Mathematics, Communicating, 1998) Math material can be difficult to read unless the student understands the language of

mathematics. There are more concepts per word, per sentence, per paragraph, than any other area of the curriculum. Eula Ewing Monroe and Robert Pachyshyn, 1996, p.80) The Illinois Learning Standard for Mathematics states that everyone must be able to read and write technical material to be competitive in the modern workplace. (1998) Therefore, it is crucial to emphasize vocab instruction in mathematics. Eula Ewing Monroe and Robert Pachyshyn have characterized math vocabulary into four categories. (1996) These categories are:

Technical Vocabulary- a word has one meaning which is math specific. This type of word is difficult to use in everyday language.

Subtechnical Vocabulary- a word has more than meaning and varies from one content area to another or from content area to everyday experiences.

General Vocabulary- a word encountered in everyday written and oral language. Used often in elementary textbooks and the meaning is not likely taught by the classroom teacher.

Symbolic Vocabulary- a word that is viewed by some as the real math vocabulary. A student must be able to recognize the alphabet, non-alphabet symbols, numbers, number expressions, and abbreviations. Mathematicians many times have a hard time with symbolic vocabulary due to its abstrativeness.

Textbooks do not do justice in describing concepts well enough and teachers must use several strategies to teach math vocabulary. Many strategies are the same ones

mirrored in other vocabulary rich content areas of the curriculum. When mathematics lesson are planned the vocabulary needs to be considered in the teaching of a lesson just as you would teach vocabulary before a reading selection in reading. Explain the language of mathematics using language as you would any other area of the curriculum.

In order to accomplish a broader mathematics vocabulary, improve mathematical communication, understand mathematical issues, and improve academic growth in the area of mathematics experts have suggested several strategies to try

Reading Strategies

It is believed that for students to better understand mathematical vocabulary students must:

- Learn to recognize symbols
- Recognize the vocabulary words that name the symbols
- Remember that these symbols and words have the same meaning and are pronounced the same
- Understand the concept expressed by the symbols and word (Francis, Holly, 1996)

Students can use strategies taught in reading to learn the vocabulary necessary to learn from any kind of text including mathematics texts. There are many benefits from learning to read that can be utilized to attain mathematical knowledge. (Monroe, Eula Ewing and Pachyshyn, Robert, 1996) Reading strategies may help students see different aspects and facets of mathematical content. These reading strategies have potential to help students arrive at a personal understanding by allowing students to take an active role and transforming the presented concepts into something meaningful to them.

Word Wall

In order for students to learn and remember new words, students must attach meaning to words and store them away for future use. (Zikovich, Pride V., 1997) Word Walls are useful in the classroom, because they provide a space where student or teacher can post key words that you expect your students to read, define, and spell automatically. The word wall develops relationships between words.

Having the words visible at a specific location creates a positive atmosphere for word learning. The Word Wall allows the students to have a specific location in the classroom where they can safely go to as a resource to build their vocabulary. (Cunningham, P. M., 1995) The words not only need to be posted, but they need to be referred to so that student learn, use and practice them. (Walther, Dr. Maria P., 1998)

Vocabulary Journals

Vocabulary Journals can improve syntax, vocabulary, and standard spelling for students. They can encourage fluency in handwriting as students practice using written language in a safe and risk-free environment. Vocabulary Journals are versatile tools (Bromely, Karen, 1998)

Vocabulary Journals motivate students to acquire vocabulary. They are a resource for building proper mathematical communication, because it provides students with proper spelling and writing. Vocabulary Journals are a good source for students to acquire definitions and use words in sentence context. (McAvoy, Natalie, 1998)

By using strategies like drawing, and writing in Vocabulary Journals research has found that it allows students to attach meaning to words and retain their meanings.

Students develop a lasting correlation between pictures and words they illustrate. (Zikovich, Pride V., 1997)

Research found that by using Vocabulary Journals provide students an opportunity to improve vocabulary and standard spelling for students. Vocabulary Journals can aid non-English speakers to learn English by writing to English language users and reading their entries. It is a versatile tool for learning. (Bromely, Karen, 1998.)

Communication

Using oral and written communications as a tool helps students reflect upon their understanding of mathematics, make connections within and outside of mathematics, and personalize mathematical concepts. When students use their words to describe their thinking, they make their understanding more precise and more general at the same time. (Bushman, 1995)

It is important to communicate by transmitting ideas quickly, efficiently, and accurately. Communication is an important strand in mathematics, and a prerequisite of communication is having a common language. When using words in many situations and in many context students come to understand full meaning of each word. Researchers have found that students understand ideas and concepts when they are able to represent their knowledge in more than one way. That is why there is a need for students to show their understanding in a variety of ways. (Checkley, Kathy, 1997)

Research has found that in order to achieve long lasting and useful mathematical competence students need to construct mathematical knowledge and create their own meaning of mathematics that they encounter. (Siegal, Marjori and Borasia, Rafaella, 1992) The NCTM suggests that teachers shift from the product to the process. This

means that teachers need to pay attention to students' mathematical reasoning and communication. Writing and conversing can develop a sense of equity in the teaching and learning of mathematics by validating multiple voices. (Whitin, Phyllis and Whitin, David J., 1997)

Mathematics standards want students to have the opportunity to grow in their ability to write and talk mathematically. This ability to shift between verbal, graphical, numerical, and symbolic modes of representing a problem allows students to formulate, solve, and communicate technical information. (State Mathematics Website)

Written Communication

A major purpose in writing is to allow students to clarify, and extend their knowledge base. Writing during mathematics instruction promotes academic gains and encourages student involvement. This is true even if a student is correct or incorrect. (Manning, Maryann and Manning, Gary, 1996) Written communication provides a clearer idea of student's strengths, needs, interest, attitudes, and understanding. Writing can improve syntax, vocabulary, and standard spelling for those having difficulties. Writing about how students approach problems compel students to think clearer and sharper. Writing in a content area can cause students to analyze, compare facts, and synthesize relevant material.

Writing about a topic requires students to think about the topic, focus on, internalize important concepts, and make those concepts to some degree their own. If students are asked to write about their understanding it causes students to improve mastery of math concepts and skills are possible if students are asked to write about their understanding. (Miller, Diane L., 1991)

Writing can stimulate dialogue between teacher and students, and can allow students to feel that their thoughts about class, about what they are learning, and even about themselves as learners are important. When given the opportunity to write about their understanding or lack of understanding of mathematics students who will not ask questions in class may express their confusion privately in writing. Writing about mathematics and experiences in class may improve some students' attitudes. Written communication can also be used as an informal assessment of understanding.

Many feel that writing should become a part of the daily routine of every mathematics classroom. Writing tasks can be carefully designed to reinforce mathematics concepts and skills being taught. Writing provides many of the thought processes teachers would like to foster in students.

Writing in a content area has a focus on students' thinking understanding of the subject area. Students who write in a content area often produce better written products with practice, but this results is an added benefit, not the primary object.

Research have found that five minutes out of four of five instructional days does not interfere with the covering the required curriculum over one academic year. Some felt that writing actually helped teachers cover material more effectively. (Miller, Diane L., 1991)

Oral Communication

Allowing students to verbalize their mathematical thinking lets students know that their thinking is important. Research maintains that verbalizing newly acquired knowledge is the most powerful study technique. Schools often fail to recognize the

cultural and linguistic strengths of students from oral literacy environment. (Miller, Diane L., 1991)

As stated before helping students to reason and verbalize their mathematics thinking convinces them that their thinking is important, and when thinking is rewarded, it will continue. Another benefit is that when students share their strategies and responses, they gain a deeper understanding of the content and begin to see there is more than one way to solve a problem. (Parke, Carol S. and Lane, Suzanne, 1997)

The Technical Education Research Center (TERC) had twelve teachers participate in a study to improve mathematical discourse among their students. One thing that these teachers required of their students was that each student was to share their thinking. As a result the students became better at sharing their ideas and thoughts. Mistakes became a fuel for discussion instead of an evil to be avoided. As the teachers spent more time listening to their students, they became shocked to find that their students did not understand ideas that the teachers believed were straightforward. (Russell, Susan Jo and Corwin, Rebecca B., 1993)

Teaching Style

Mathematics education is changing, because of the dissatisfaction in the achievement of our students. Researchers are looking for answers to why students' mathematics achievements are poor compared to other countries. One research project by the Technical Education Research Centers (TERC) worked with 12 teachers over a three-year period to investigate ways to develop mathematical communication in their classrooms. The 12 teachers involved all agreed that there was a need for change, however, the change needed to be gradual. They felt change that came about hurriedly

would not be well accepted by their students and would discourage the teachers themselves.

Researchers found five common threads when the 12 teachers were interviewed. These five changes were:

1. More mathematics time was planned and scheduled for. This resulted in the students becoming more engaged in mathematics.
2. Different types of questions were asked during mathematics instruction. Teachers, also, avoided accepting the first right answer that was offered by students.
3. Errors became a springboard for discussion rather than an evil to be avoided.
4. Mathematics knowledge became focused on finding patterns, describing and analyzing those patterns, and devising conjectures, generalizations, formulas and rules about how mathematical objects behave.
5. Time was allowed for reflection and analysis, for students to express their approach towards a problem. This required the teachers to listen more accurately to their students and to probe beneath the surface for understanding.

Many of these same ideas can be found in the different mathematics teaching philosophies. One researcher was able to identify five philosophical approaches to teaching mathematics. (Mathematically Correct, 1996) This researcher felt that all new programs are experimental and need to be used in small doses to be the most beneficial. Proponents of these philosophies believe that there may be more than one method to solve a problem, and that one method may be better to solve some types of problems

while another method may be better to solve another problem. The five philosophical approaches to teaching mathematics are:

1. Constructivism or discovery learning- This approach allows students to explore mathematical concepts, such as rules and methods on their own. Teachers must be well trained in this method for this to work well. Opponents to this find that the discovery takes a long time and that less material can be covered. Opponents believe that many students will discover the wrong rules during this type of approach
2. Whole Mathematics- This approach implies that students should write essays and have discussion groups about mathematics. Opponents feel that students will spend to much time writing essays and not enough time on basic skills.
3. Complete Mathematics- This philosophy has students "communicating mathematically", however, students are not taught the terminology, symbols, and syntax needed to communicate mathematically.
4. Integrated Content- This philosophy believes that mathematics is not split into neat subtopics like algebra, geometry, and trigonometry. Thus mathematics should not be taught that way. Proponents feel that if there is no orderly sequence that it becomes hard to assess individuals, groups, or the whole mathematical program.
5. Cooperative Learning/Cooperative Assessment- This philosophy is based on the belief that real-world jobs use cooperative efforts of groups and competition among individual students is not good for learning and doesn't

represent the real-world very well. Opponent's claim that the distribution of the work and learning involved is not divided equally among members.

Anxiety Awareness

It has been documented that many middle-level students have no confidence in their abilities while doing mathematics, and as a result take the minimum number of required mathematics classes. This will in the end interfere with future success in society that is growing dependent on mathematics literacy. (Steele, Diana and Arth, Alfred A., 1998) For students to enhance their lives they must see a need for mathematics, become confident in their ability to do mathematics, and understand mathematics in a way that will give them the power to make sense of the world around them, and to confront and solve new problem situations.

Positive instruction and assessment in class can convince students that they can do mathematics. The teacher's attitude toward mathematics influences students' attitudes. One major resource of mathematics anxiety is the teacher's cycle of teaching mathematics. Teacher to often follow this sequence when teaching mathematics:

1. explain the problem
2. do the problem
3. memorize the algorithm
4. correct the problem
5. test for correct methods

On top of this teaching sequence the time spent in mathematics class is practicing procedure with no real world connection. Mathematics doesn't make sense. To these

students they are just memorizing unconnected bits of information. Once these students become mathematics avoiders, they limit their future for many possible occupations.

Teachers need to be flexible about how students reach and express their solutions. By doing this teachers will increase participation and encourage intuition. Flexibility can help facilitate cooperation, reduce stress, and increase positive attitudes. Students will then develop confidence in their thinking and trust others to help them.

When an error is made, a learning opportunity arises, students errors are necessary steps toward reconstruction of ideas at higher level of understanding, if teachers deny students the right to be wrong they are denying the complexity and interrelatedness of mathematics ideas. When a teacher emphasizes how and why problems are solved rather than focusing on correct answers, students may become less apprehensive about making mistakes. When teachers strive to understand what students think and how they think, they help to create a positive atmosphere.

When a student is asked to explain how they think about a problem, they are helping them understand that working out mathematics is a cycle of thinking-developing, proving, and evaluating a theory or solution to a problem or situation. Students learn there are many ways to think about finding the same solution.

Teachers can avoid negative mathematics experiences, by asking for volunteers and not singling students out. They can encourage students' positive attempts when working on a solution to a problem. Teachers can bring these negative attitudes about mathematics out in the open, help students explore their attitudes and anxieties about mathematics through discussion can help them find out when their anxieties began, both teacher and students can discuss positive and negative personal experiences, knowing that

teachers care about their feelings help them engage students in learning, students are then encouraged to replace negative comments with positive ones. Teachers also need to value students' methods of thinking and respect the students' personal frame of reference. They need to listen to students' questions and justify their answers.

Taking risks is hard for many students, especially those that are anxious about mathematics. Many times working in small cooperative groups allows mathematics anxious students the opportunity to share their thinking during these small group discussions. Working in small groups of three to four students often reduces anxiety because students do not have sole responsibility for finding the answers or completing the activity. Working together in a structured setting promotes teamwork as well as active learning. Students whose confidence was challenged by the assignment to explain mathematics understanding orally and in writing felt safe and confident when they worked together. Taking risks became less threatening. (Melton, Julie A., 1996)

For in class and out of class activities it is helpful to use manipulative and concrete materials, such as base ten blocks for decimals and percents.

Time needs to be provided for students who miss concepts maybe through peer tutoring. Most successful programs were those that featured teachers who attempted to change the way the subjects were perceived and learned mathematics

1. materials introduced slowly
2. instructors assumed no prior mathematics knowledge
3. Instructors encouraged students to talk about their thought processes in learning (Tooke, James D. and Lindstrom, Leonard C., 1998)

Teachers can create mastery level of rubrics with their students. This way all involved are conscious and actively aware of the assessment. The MCTM calls for evaluation that includes dialogues between teacher and student in order to assess thinking. Teachers can use a variety of techniques by asking oral questions; observing students who work with models, and having students demonstrate why a procedure works.

Asking students to explain what they are thinking and observing their concrete representations can reveal their conceptual knowledge.

Although feeling about mathematics anxiety should be appreciated it should be noted the standards for excellence in learning in the class should not be lowered. Students know when they have accomplished meaningful tasks. Lowering expectations only convinces students that they do not have what it takes. They will not trust their thinking or build mathematics confidence.

Educators must assume the responsibility for creating an educational environment that encourages students to evaluate theory own learning and accept responsibility for that learning. When students become responsible for their thinking, they can learn to become powerful mathematics problem solvers. We want our students to think and become lifelong learners.

Educational Games that Expand Learning

Students do learn by memorizing basic factual information, however, learning by wrote could be unpleasant and counterproductive. Researchers feel that a student's knowledge will not fully develop without thinking, and therefore it will not support more

complex challenges to come. Thinking must accompany repetition so that a student is able to construct a knowledge base and remember. (Wakefield, Alice, 1998)

Students rely on an atmosphere that fosters and supports complex thinking and provides an opportunity for students to interact and exchange views. The interaction of students at play provides a natural challenge that many students need. Students need to make a mental connection, so that it can be remembered. Students cannot see, hear, or remember what they cannot understand.

Games provide students with practicing time with real world connection. Many students are simply better at understanding and retaining abstract math concepts through physical experiences rather than pencil-and-paper drills. (Brunetto, Carol Ford, 1997) Games allow students to take risks and therefore become less threatened by the concept of mathematics.

Project Objectives and Processes

After reviewing the literature on the problem of students' poor understanding of content vocabulary in mathematics, the researcher created the following project objective:

> As a result of increased instructional emphasis on content vocabulary in mathematics, during the time period of September 1998 to April 1999, the targeted fifth grade students will improve understanding of content vocabulary in mathematics that interfered with mathematical issues and academic growth. The results will be measured by teacher-mathematical concepts and the ability to use proper vocabulary in communicating mathematically, as measured by teacher-constructed vocabulary test, and review of logs.

In order to accomplish this project objective, the following processes are necessary:

1. Identify key vocabulary words that will foster communication and growth.
2. Develop learning activities that address vocabulary mastery.

Project Action Plan

Before any of the interventions could be implemented, several steps were taken. Key vocabulary was identified from the district's adopted mathematics series, *Math.* (Scott Foresman/Addison Wesley, 1998) An anxiety survey was found in *Math for Humans.* (Wahl, Mark, 1997) Learning activities involving teacher modeling, problem-solving logs, and vocabulary logs. These activities were designed to be intertwined into the regular mathematics curriculum of the targeted fifth grade classroom.

The following is a list of mathematics topics, chapters they represent, and the order they were taught.

September

Chapter One

- Reading graphs, describing data, and facts review

October-November

Chapter Two

- Understanding whole numbers
- Understanding decimals
- Adding and subtracting whole numbers and decimals

December-January

Chapter Six

- Exploring angles and polygons
- Analyzing polygons

Chapter Ten

- Using linear measurement
- Exploring perimeter
- Finding area and perimeter

February

Chapter Seven

- Understanding fractions

March- April

Chapter Eight

- Adding and subtracting fractions
- Adding and subtracting mixed numbers
- Using customary linear measurement

May

Chapter Nine

- Developing fraction multiplication sense
- Extending multiplication

Chapter Three

- Multiplying with whole numbers
- Multiplying with whole numbers and decimals
- Multiplying with decimals

June

Chapter Four

- Developing division sense
- Division

Chapter Five

- Division

The following activities were done in each chapter:

- Pop quiz
- Chapter assessment
- Problem solving log activities
- Vocabulary journal activities
- Mathematical skills taught and practiced
- Mathematical vocabulary taught
- Mathematical vocabulary activities

These will all be further explained in chapter four.

A particular chapter lesson may be taught as follows:

- Problem of the Day-read problem together as class, and discuss words used and their meanings
- Language development activity
- Identify prior knowledge of skill through an activity
- Briefly introduce skill
- In whole group, small group, or alone students will explore the possible uses for a particular skill and develop their mathematical ability to use the skill correctly.

Twice a week students will problem solve using their problem solving logs and Problem of the Day, a problem-solving program developed by the textbook publisher. Also, on the first day of each week students are assigned three pages from their Arithmetic Done Daily books, so as to practice basic mathematical skills. These three pages are gone over as a class on Fridays. When ever mathematical vocabulary is introduced students either in whole group, small group, or alone are to identify mathematical vocabulary for a lesson, write the word in their vocabulary log, write a definition, draw a picture that represents the word, and use it properly in a sentence.

Methods of Assessment

In order to measure the effects of the interventions for this project the teacher/ researcher will use several types of assessment throughout the research period. The teacher/researcher will use a vocabulary pretest and posttest to measure the growth of mathematical vocabulary knowledge. This will be given in the beginning of the research period and at the end of the research period.

Also, the teacher/researcher will utilize a student survey that will be given at three different times of the study. The three times the survey will be given to the students are the second week of the study, the middle of the study, and second to last week of the study. A parent survey will be given to parents mid-way of the project.

Observations through the use of a checklist will aid the teacher/researcher in identifying change of verbal and nonverbal cues within the study period. This will be done on a daily basis.

Twice a week a problem-solving log will be used to help guide students

through the problem solving process. The students will be asked to identify the answer to a problem, state the process they used to reach an answer, and defend they method they used. This will be graded using a rubric designed by the teacher/researcher. Both the problem-solving log and rubric are loosely based on the states mandated mathematical written test.

Finally, Arithmetic Done Daily will be graded and checked the last day of each week. The students will grade their own papers and as a whole class we will discuss the steps needed to solve each individual problem.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective for this research project was to improve understanding of content vocabulary in mathematics that interfered with mathematical issues and academic growth. Evidence for the existence of the problem included teacher observations, mathematics vocabulary pretest, mathematics anxiety survey, Arithmetic Done Daily (ADD), class discussion, and assessment of math performance. The teacher/researcher chose to use reading strategies to teach mathematical content vocabulary. The reading strategies that the teacher/researcher used were vocabulary journal, word wall, and games. The teacher/researcher also provided more time for mathematical communication both verbal, and written through the use of problem-solving logs, and class discussions. The teacher/researcher changed her teaching style to include cooperative learning and multiple intelligence activities. The teacher/researcher made an effort to look for signs of mathematical anxiety and to lower and respect mathematical anxiety. Games were also used by the teacher/researcher to teach and reinforce mathematical concepts and mathematics vocabulary. The teacher/researcher used games such as Bingo, dice games, and pencil and paper games. (Appendix G)

The teacher/researcher began this project in the beginning of the school year by having the students take a mathematics vocabulary pretest. (Appendix A) Key vocabulary was identified from the district's adopted mathematics series, *Math* (Scotts Foresman/Addison Wesley, 1998). (Appendix B) The pretest was given over a five-day period. The first four days students were given tests over 26 words. The fifth and final day the students were tested over 20 words. Students in the study were given an anxiety survey found in *Math for Humans* (Wahl, Mark, 1997). (Appendix C) This survey was given three times during the study to help measure students' anxiety level towards mathematics. The same survey was given to the students' parents in September to measure their anxiety towards mathematics. The teacher/researcher wanted to see if there was any correlation between a parent's mathematics anxiety and their student's.

After the mathematics vocabulary pretest was given the teacher/researcher began teaching topics from the district approved mathematics textbook in early September. The teacher/researcher began with chapter one, which was to read graphs, describe data, and review facts. This chapter was scheduled to only take about a month to cover, however, it lasted until the end of October. The material in chapter one seemed to be more detailed orientated than the teacher/researcher expected and the students were not grasping the concepts as quickly as the teacher/researcher had hoped.

Chapter two was the next chapter to be taught. The topics to be covered included understanding whole numbers, understanding decimals, and adding and subtracting whole numbers and decimals. This also took a longer time to cover. Students seemed to have a difficult time understanding place-value, therefore, many manipulatives, such as place value blocks and charts were used.

Starting in December students began working on exploring angles and analyzing polygons. Many manipulatives were used to convey concepts to the students. Chapter ten followed with linear measurement, perimeter, and area. These two chapters were completed ahead of the teacher/researchers expected scheduling, because many of the lessons were combined and students were able to remember past lessons from various grade levels. Both chapters were be completed by the first week in January.

Chapters seven, eight, and nine were combined. Understanding fractions, adding and subtracting fractions, adding and subtracting mixed numbers, and using customary linear measurement, developing fraction multiplication sense, and extending multiplication were the topics covered. The teacher/researcher used manipulatives to teach the concepts to the students. Manipulatives used were things such as fraction bars, fraction circles, and food. Beginning the third week of January until the middle of May there were many interruptions to the school day. During this time period the students had one and a half weeks of standardized testing on a national level, one week of standardized testing on the state level, one week of piloting a state level standardized test, and spring break.

From mid-May until June chapter three was covered. Chapter three was about multiplying with whole numbers, multiplying with whole numbers and decimals, and multiplying with decimals. The last two weeks of school were spent on chapter five, division.

During the project several activities were repeated for each topic area. These activities included:

- Pop quizzes
- Chapter assessments

- Problem solving log activities
- Vocabulary logs activities
- Mathematical skills taught and practiced
- Mathematical vocabulary taught
- Mathematical vocabulary activities

It was the intention of the teacher/researcher to quiz students over topics once a week, but this became unrealistic, because of everything that needed to covered within the school year, and all of the interruptions that took place. Quizzes were given about half way through a chapter to measure students' progress.

Chapter assessments took place after each chapter, accept in the case when chapters were combined. When an individual chapter was covered students were given the book's test; however, when chapters were combined the teacher/researcher would combine test questions from the chapters involved.

It was the intention of the teacher/researcher to have students complete the Problem of the Day with each new lesson. (Appendix H) The teacher/researcher had hoped that after doing several Problems of the Day students would be able to complete the problem solving log alone and solve the Problem of the Day. The above mentioned was tried, however, the result was poor. The teacher/researcher decided to do problem solving logs two times a week and give four minute timed test over basic facts the other three times a week. Doing Problem of the Day just two times a week allowed the teacher/researcher to choose which Problem of the Day students would solve. The teacher/researcher chose Problem of the Day problems that were relevant to the topic students were learning about. The teacher/researcher tried to find problems that had realistic undertones to it. Students

also asked if they could work in small cooperative groups of no more than three to solve the Problem of the Day. The teacher/researcher allowed the suggestion, but stipulated that all students must fill out their Problem Solving Log and be able to explain any areas on the problem solving log the teacher/researcher.

Mathematical skills were taught and practiced. Manipulatives were added whenever possible to engage the students in active learning. Mathematics vocabulary was taught using the Vocabulary Journal, word wall, and vocabulary activities.

A particular chapter lesson many times were taught as follows:

- Problem of the Day-read problem together as class, and discuss words used and their meanings, or four minute timed test over basic facts
- Language development activity
- Identify prior knowledge of skill through an activity
- Briefly introduce skill
- In whole group, small group, or alone students would explore the possible uses for a particular skill and develop their mathematical ability to use the skill correctly

It was the intention of the teacher/researcher to direct how the lessons were to be taught, skills to be drilled, and activities to be used. The lessons were to be driven by the teacher/researcher. Students were to be lectured on a mathematical concepts. After some research and prompting from students the teacher/researcher let the students direct the lessons being taught and how activities were to be used. The teacher/researcher became the facilitator in the students learning process. Students were given a concept and in small groups or alone they would come up with ideas, patterns, and methods that explained the concept being taught. The students would then share their ideas as a whole

class, and the teacher/researcher would clear up any misconceptions or guide the students to the right direction if they got off course.

On the first day of each week students were assigned three pages from their Arithmetic Done Daily (ADD) book. (Appendix E) This ADD allowed students to practice basic mathematical skills. These three pages were gone over as a class on Fridays.

Presentation and Analysis of Results

In order to measure the effects of the interventions for this project the teacher/researcher used several types of assessment throughout the research period. These assessments included:

- Mathematics vocabulary pretest and posttest
- Mathematics anxiety survey
- Teacher observation checklist
- Problem solving log
- Arithmetic Done Daily (ADD)

Mathematics Vocabulary Pretest and Posttest

A mathematics vocabulary pretest was designed to measure the students' prior knowledge of mathematics content vocabulary. The same test was given at the end of the research period as the posttest. (Appendix A) The posttest was given to the students to measure the growth of mathematical vocabulary knowledge over the research period. Both tests were given over a five-day period and students were asked to match a definition with a mathematics vocabulary word. The first four days of testing the students were tested over 26 words and the fifth day students were tested over 20 words.

The words were arranged in alphabetical order so that the students had less chance of word association.

An analysis of the control group students' responses to the mathematics vocabulary pretest showed that the students were familiar on average with 21% of the vocabulary that would be presented throughout the research period in mathematics. The students in the control group were able to identify approximately 26 of the 126 words tested on the mathematics vocabulary pretest. The non-control group scored on average 28%. The control group scored on average 35 of the 126 words tested.

The posttest of the mathematics vocabulary test showed that the students in the control group were able to identify an average of 62 words or 49%. That was an increase of 36 words or 28%. The non-control group averaged 63 words on the posttest or 50%. This was an increase of 28 words or 22%. (See Table Three and Four)

Table Three

Control Group Mathematics Vocabulary Pretest and Posttest Results

Student	Pretest Test 1	Posttest Test 1	Pretest Test 2	Posttest Test 2	Pretest Test 3	Posttest Test 3	Pretest Test 4	Posttest Test 4	Pretest Test 5	Posttest Test 5	Pretest Overall	Posttest Overall
A	7	15	3	18	5	17	2	5	1	6	18	61
B	5	14	1	10	7	9	4	6	2	10	19	49
C	11	9	7	10	4	14	1	5	0	5	23	43
D	11	17	7	13	7	21	3	12	3	16	31	79
E	11	14	10	11	10	20	6	8	3	10	40	63
F	16	13	10	17	10	23	3	15	1	17	40	85
G	10	18	4	2	5	5	3	3	1	7	23	35
H	7	8	6	8	4	7	0	7	0	16	17	46
I	15	15	4	10	15	14	5	16	7	17	46	72
J	10	14	6	19	7	24	7	18	6	20	36	95
K	14	15	5	6	10	8	6	7	6	9	41	45
L	11	15	3	11	7	12	1	14	0	16	22	68
M	6	8	2	6	0	8	2	6	0	9	10	37
N	9	18	4	13	5	16	2	10	2	10	22	67
O	8	9	3	10	7	13	2	8	4	12	24	52
P	9	18	4	15	7	12	5	13	2	10	27	68
Q	9	19	5	13	1	16	2	10	3	12	20	70
R	5	12	4	9	4	12	1	14	0	16	14	63
S	9	15	16	18	10	22	3	13	8	18	46	86
T	8	5	2	8	4	18	4	12	0	3	18	46

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Table Four

Non-Control Group Mathematics Pretest and Posttest Results

Student	Pretest Test 1	Posttest Test 1	Pretest Test 2	Posttest Test 2	Pretest Test 3	Posttest Test 3	Pretest Test 4	Posttest Test 4	Pretest Test 5	Posttest Test 5	Pretest Overall	Posttest Overall
AA	15	15	11	21	16	24	7	17	7	18	56	95
BB	8	15	3	13	5	20	3	10	4	5	23	63
CC	12	18	6	15	11	16	4	15	4	13	37	77
DD	7	10	7	7	3	13	1	7	4	7	22	44
EE	10	17	4	9	7	20	2	13	2	13	25	72
FF	4	6	0	20	0	16	2	10	18	4	6	56
GG	21	24	13	24	14	19	15	24	14	20	77	91
HH	9	14	6	14	5	14	8	14	5	20	33	76
II	12	5	10	6	19	11	2	11	3	6	46	39
JJ	11	16	14	19	13	21	8	14	6	15	52	85
KK	7	17	11	22	10	24	7	14	7	15	42	15
LL	5	8	2	4	7	3	3	2	2	2	19	19
MM	5	14	6	15	9	14	5	13	7	10	32	66
NN	6	10	5	15	7	12	3	7	6	6	27	60
OO	11	22	8	23	9	21	11	21	9	19	48	87
PP	9	10	4	19	2	13	3	7	6	6	24	55

Mathematical Anxiety Survey

Three times during the research period students were given a survey that was used to measure their anxiety level towards mathematics. (Appendix C) The survey consisted of ten questions. The students were required to read a question and rate the statement on a likert scale from one to five. One being almost never true, or have little feeling about and five being true, or have a strong emotional reaction.

Questions four, six, eight, nine, and ten were targeted for deeper analysis for this study. These targeted five questions dealt specifically with mental and physical reactions towards mathematics. The other questions dealt primarily with attitudes towards themselves when it came to mathematics and students' attitude towards the subject area of mathematics.

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The first survey revealed that the targeted fifth grade control group on average of scored a 24. Eleven of the students in the control group who took the survey gave themselves at least one statement a four or five. This seems to indicate that 55% of these particular students have some strong feelings and/or strong emotional reactions towards mathematics.

The non-control group on average scored a 21 on the mathematics survey. Four students who took the survey gave themselves at least one score of four or five. Only 21% of the students felt strong about any statement about any statement on the survey. This particular group of students did not have as strong of discomfort or anxiety when it came to mathematics. The other surveys showed students' anxiety level lower. Only two students in the study ranked any answer above a three when it came to the second and third time the survey was taken. All other students ranked their answers a one or two. This seemed to indicate to the teacher/researcher that the majority of students felt the questions to be almost never true, or the students had little feeling towards the questions.

During the fourth week of school the parents of the control and non-control groups were surveyed to identify their anxiety level towards mathematics. The parents were given the same survey as the students. The teacher/researcher wanted to see if there was any correlation between a parent's attitude towards mathematics and the students'.

The parents' survey showed that the average score was 12 points. Only four parents expressed any discomfort and/or anxiety towards mathematics. The majority of parents felt very confident. One parent even remarked that they enjoyed mathematics and felt that a little anxiety when it comes to mathematics is good for performance. Yet, another parent expressed that she felt very uncomfortable taking the survey. She felt

embarrassed that her child or anyone else might learn that she felt inadequate when it came to mathematics.

The students' survey when compared to the parents' survey seemed to show no correlation. The students had stronger anxiety towards mathematics at the beginning of the study, but this diminished as the product continued. The parents on the other hand seemed to be comfortable when it came to mathematics and expressed no anxiety.

Teacher's Observation Checklist

The teacher/researcher developed a checklist that she used to identify verbal and nonverbal signs of students' attitudes towards mathematics, and correct vocabulary usage. (Appendix D) The teacher/researcher used the checklist during mathematics instruction and after instruction to aid in collecting data that may show patterns, problem areas, and attitudes towards mathematics. The teacher/researcher found that the students showed many negative nonverbal and negative verbal cues. The negative nonverbal cues that the teacher saw included:

- Students were demonstrating off task behaviors
- Students slouched in their seats
- Students appeared to lethargic and bored

Their use of proper mathematics vocabulary was poor to none. When students did use mathematics vocabulary it was usually used incorrectly. For example, students would remark that the number nine in the number 159 was worth nine. When the students should of the said that the digit nine in the number 169 has the value of nine.

As the study progressed the teacher/researcher began to see many positive changes. The students' non-verbal cues became more positive as the study progressed. The teacher/researcher noticed the following:

- Students were demonstrating more on task behaviors
- Students sat tall in their seats
- Students became engaged in the lessons and often volunteered to help others or to share their thoughts with the class

When students would share their mathematical ideas both verbally and non-verbally mathematical vocabulary was used approximately 85% of the time. For example, a student could state that when two addends are added together the result will be a sum. By the end of the project period the students themselves were doing the actual teaching of mathematics lessons to each other and the teacher/researcher became the facilitator in the classroom.

Problem Solving Log

Twice a week a Problem Solving Log was used to help guide students through the problem solving process. (Appendix I) The students were asked to identify the answer to a problem, state the process they used to reach an answer, and defend the method they used. The Problem Solving Logs were graded using a rubric. (Appendix J) Both the Problem Solving Log and the rubric were made based loosely on the state mandated mathematical written test. Problem of the Day, problem solving activities written by the district's adopted mathematics series, was used in conjunction with the Problem Solving Log.

At the beginning of the project the teacher/researcher walked the students through the entire problem solving process. The entire process was done together as a whole class, but students would individually fill out their Problem Solving Logs using the information provided by the teacher/researcher and other students.

In the beginning of the study students were negative in their approach. Students would complain, roll their eyes, and slouch down in their seats. As the project progressed the students were given more responsibility in the actual problem solving of the Problem of the Day. As the teacher slowly relinquished her role in the actual problem solving activity the students began to take a more active role. Students were allowed to work in groups no larger than three or independently. The majority of students worked in small groups and met success in the problem solving process. Three students chose to work by themselves.

While the students worked the teacher/researcher would walk around the classroom and aid anyone who needed assistance. In one case two students were observed working independently, yet they positioned themselves in such a location that they could overhear another's group problem solving strategies. The teacher/researcher made it a point to sit down with them periodically and have these students explain their thought process they were using to solve their problem.

When the students worked as a whole group and the teacher/researcher led the instruction students would score high on the Problem Solving Log. Scores dropped significantly when the teacher/researcher became the facilitator of the lesson. Many of the scores were no higher than a four, which meant that students were only partially accomplishing the main objective of the exercise, to identify the answer to a problem,

state the process they used to reach an answer, and defend the method they used. As students brought their Problem Solving Logs to be scored the teacher/researcher would ask the students questions. The teacher/researcher did this so that the students would expand upon their answers. The students would then go back to their seat and write what they told the teacher/researcher, and bring the log back for another evaluation. As the study progressed students would automatically expand upon their answers and the majority of the students received full credit. Also, the teacher offered a reward to any student that scored perfect score, which help to motivate those students that needed external motivation. The reward was a small piece of candy. This extrinsic motivation also seemed to diminish as the confidence of the students increased.

Arithmetic Done Daily (ADD)

The teacher/researcher used Arithmetic Done Daily (ADD) on a weekly basis to enrich and review mathematical operations. (Appendix E) ADD was part of the required curricular material to be used in the teacher/researcher's school district. The students in the targeted fifth grade were required to complete three pages from their ADD each week. Each Friday students and the teacher/researcher would go over the problems that were assigned for the week.

The teacher/researcher found that students were not meeting much success in completion of these pages. The students were not completing the pages and many students stated that they couldn't understand the directions given. Therefore, many students would not complete their ADD assignment each week or if they did complete the ADD assignment they did not have much success.

As the project progressed so did the success of the students with their ADD assignments. More students began to complete the assignments and scores raised. By the end of the project all students were completing their ADD assignments each week and a few even went ahead each week on their own.

Conclusions and Recommendations

Based on the analysis of the data on the fifth grades class, the students' showed an improvement in the area of understanding content vocabulary for mathematics. Lack of knowledge of the vocabulary no longer seemed to be an issue in the communication of mathematical issues and in academic growth. All students who participated in the study increased their knowledge of mathematics vocabulary. All students' anxiety towards mathematics decreased when it came to mathematics. Academic growth was evident in all students. This was seen through daily assignments, weekly ADD assignments, quizzes, chapter tests, standardized testing, state standardized testing, and participation and attitude in the classroom. One student in the control group even exceeded state standards on the state mandated standardized test in mathematics by scoring a perfect score in three areas. Another student in the control group and one in the non-control group exceed state standards by scoring a perfect score in two areas on the mathematics section of the state mandated standardized test.

This confidence in their ability seemed to effect their academic ability in other areas of the curriculum. Students began to take an active role in their education. The students in the control group were no longer passive learners, but active learners. They wanted to share the knowledge they knew, and had learned. They were willing to even share their misconceptions and ask others to help them form the correct solutions. This spilled over

into other areas of the curriculum. This study proved to be a positive boost to their self-esteem, educational progress, and peer relations.

The study has made a difference in the development of vocabulary and academic growth in mathematics. The teacher/researcher feels that many of the strategies that were used were instrumental in the success of this particular project. Especially instrumental in the growth of the students were the following interventions:

- Reading Strategies
    - Word Wall
    - Vocabulary Journals
- Communication
    - Oral
        - Class discussions
    - Written
        - Problem Solving Logs
- Teaching Style
    - Multiple Intelligence
    - Cooperative Learning
    - Allowing more time for mathematics
- Anxiety Awareness
    - Surveys
    - Class discussion
- Educational Games that Expand Learning
    - BINGO

- Around the World
- Dice games

Changes the teacher/researcher would make would be in the area of the anxiety survey. The survey needs to be more user friendly. The survey's likert scale was hard to understand for both the students and the parents involved in the study. Many students and parents were concerned that there was not a score for when they had not experienced a described attitude or feeling. This caused some confusion while the surveys were taken and the teacher/researcher feels that the surveys are not as accurate as she may have hoped them to be. The teacher/researcher relied more on the written notes that students and parents placed on the surveys, discussions she had with students about the survey, and through observations using the checklist.

The teacher/researcher would also allow students to become more acclimated to the Problem Solving Log assignment, before they are allowed to go off and solve the Problem of the Day by themselves or in small groups. This would allow the students to become more comfortable with the process being introduced. The teacher/researcher feels that any students that feels comfortable with the process and demonstrates this to the teacher/researcher should be allowed to work on the Problem of the Day using the Problem Solving Log by themselves and possibly help others in the understanding of the processes.

The same can be said about the Vocabulary Journals. If students preferred working as a whole class, small groups, or individually on this they should be allowed to. The teacher/researcher did not see any real difference in the results. The students were being

exposed to the mathematics vocabulary no matter how the Vocabulary Journals were being filled out.

The teacher/researcher feels that this study was a positive one. The study exposed students to necessary mathematics vocabulary needed for communication and academic growth in mathematics. The study also exposed students to the necessary procedures needed to be successful on the state mandated mathematics test. These procedures the students were exposed to helped them think through mathematics problems, made students aware of the actual steps they used to solve a problem, and allowed them the opportunity to support why they did what they did to solve the problem.

The teacher/researcher found supporting research by educational professionals that felt that writing and vocabulary development is necessary in all curricular areas, especially mathematics. If students are unable to read and understand the directions to a mathematics problem they will be unable to answer the problem. It should also be noted that many educational professional believe that writing in a curricular area demonstrates a students true knowledge of the material being taught, and allows another outlet for true authentic assessment.

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APPENDIX A

VOCABULARY PRE-TEST AND POST-TEST

NAME _____ DATE _____

Math Vocabulary Pretest

Match each word or words with its meaning.

___ 1. acute angle

___ 2. acute triangle

___ 3. algebraic expression

___ 4. angle

___ 5. area

___ 6. associative property

___ 7. bar graph

___ 8. base

___ 9. benchmark numbers

___ 10. capacity

___ 11. Celsius

___ 12. centimeter

___ 13. chord

___ 14. circumference

___ 15. common denominator

___ 16. common multiple

___ 17. commutative property

___ 18. compatible numbers

___ 19. composite numbers

___ 20. congruent polygons

___ 21. coordinates

___ 22. cube

___ 23. customary system

___ 24. decimeter

___ 25. degree

___ 26. denominator

A. a graph that uses bars to show data

B. a whole number greater than 1 that has more than two different factors

C. an angle that has a measure less than 90 degrees

D. the bottom of a polygon or solid, also, a number multiplied by itself the number of times shown by an exponent

E. numbers that are easy to work with mentally

F. a triangle with all angles less than 90 degrees

G. the bottom number of a fraction that tells the number of equal parts in the whole

H. polygons that have the same size and shape

I. a number that is easy to work with, such as 10, 50, 100, 500, 1,000, or 1,000,000

J. changing the order of addends or factors does not change the sum or product

K. an expression that contains a variable

L. the volume of a solid given in terms of liquid measurement

M. system of weights and measures, using yard, gallon, and ounces as units.

N. a line segment with both end points on a circle

O. when the grouping of addends or factors is changed, the sum or product stays the same

P. a unit of measure for angles and temperature

Q. a number that is a denominator of two or more fractions

R. two rays with a common endpoint

S. a pair of numbers used to locate a point on a graph

T. a unit for measuring length in the metric system

U. a solid figure whose 6 faces are all squares

V. the number of square units needed to cover a closed figure

W. temperature scale in which water boils at 100*C and freezes at 0*C

X. the distance around a circle

Y. a number that is a multiple of two or more different numbers

Z. a unit for measuring length in the metric system

NAME _____

DATE _____

Math Vocabulary Pretest 2

Match each word or words with its meaning.

___ 1. diameter

___ 2. digit

___ 3. distributive property

___ 4. dividend

___ 5. division

___ 6. divisor

___ 7. edge

___ 8. end point

___ 9. equal ratios

___ 10. equation

___ 11. equilateral triangle

___ 12. equivalent decimals

___ 13. equivalent fractions

___ 14. evaluate

___ 15. expanded form

___ 16. exponent

___ 17. factor

___ 18. Fahrenheit

___ 19. fraction

___ 20. gram

___ 21. greatest common factor

___ 22. height

___ 23. horizontal axis

___ 24. improper fractions

___ 25. intersecting lines

___ 26. isosceles triangles

A. fractions that name the same part of a region, part of a set, or part of a segment

B. a triangle that has at least two equal sides

C. a line segment that goes from one point on a circle through the center to another point on a circle

D. decimals that name the same amount

E. lines that cross at a point

F. the symbols used to show numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9

G. to find the number an algebraic expression names by replacing a variable with a given number

H. a fraction greater than or equal to one

I. multiplying a sum by a number is the same as multiplying each addend by the number and then adding the products

J. a triangle with three equal sides

K. the left-to-right number line on a graph

L. the number to be divided in a division number sentence

M. a number sentence that uses the equal sign (=) to show that two expressions have the same value

N. the length of the perpendicular line segment from the vertex to the base of a triangle

O. an operation that tells how many groups there are or how many are in each group

P. a way to write a number that shows the place value of each digit

Q. the greatest number that is a factor of each of two or more numbers

R. the number by which a dividend is divided

S. a number that tells how many times another number is used as a factor

T. a unit for measuring mass in the metric system

U. a line segment at which two faces of a solid figure meet

V. any number that divides another number with a remainder of 0

W. a way to compare equal parts with a whole

X. a point at the end of a ray or line segment

Y. temperature scale in which water boils at 212*F and freezes at 32*F

Z. ratios that give the same comparison

NAME _____ DATE _____

Math Vocabulary Pretest 3

___ 1. kilogram

___ 2. kilometer

___ 3. leaf

___ 4. least common denominator

___ 5. least common multiple

___ 6. line

___ 7. line graph

___ 8. line of symmetry

___ 9. line plot

___ 10. line segment

___ 11. liter

___ 12. mean

___ 13. median

___ 14. meter

___ 15. metric system

___ 16. milliliter

___ 17. millimeter

___ 18. mixed number

___ 19. mode

___ 20. multiple

___ 21. net

___ 22. number line

___ 23. numerator

___ 24. obtuse angle

___ 25. obtuse triangle

___ 26. ounce

A. the product of a given whole number and any other whole number

B. the least common multiple of the denominator of two or more fractions

C. the middle number when data are arranged in order

D. a unit for measuring weight in the customary system

E. part of a line that has two end points

F. a unit for measuring mass in the metric system

G. a graph that connects points to show how data changes over time

H. a triangle with one angle greater than 90*

I. a decimal system of weights and measures, using the meter, liter, and grams as units

J. a graph that uses symbols above a number line to represent data

K. a unit for measuring capacity in the metric system

L. a line that shows numbers in order using a scale

M. a unit for measuring length in the metric system

N. a unit for measuring length in the metric system

O. the part of a stem-and-leaf plot that shows the ones digit of a number

P. an angle with a measure greater than 90*

Q. the number found when the sum of two or more numbers is divided by the number of addends, also called the average

R. a unit for measuring length in the metric system

S. the least number that is a multiple of two or more different numbers

T. the top number of a fraction that tells the number of equal parts considered

U. a number that has a whole-number part and a fractional part

V. a line on which a figure can be folded so that both halves are congruent

W. a unit for measuring capacity in the metric system

X. a pattern that can be cut out and folded into a solid

Y. a straight path that is endless in both directions

Z. the number or numbers that occur most often in a set of data

NAME _____

Date _____

Math Vocabulary Pretest 4

Match each word or words with its meaning.

___ 1. outcome

___ 2. parallel lines

___ 3. parallelogram

___ 4. pentomino

___ 5. percent

___ 6. perimeter

___ 7. period

___ 8. perpendicular lines

___ 9. pictograph

___ 10. polygon

___ 11. pound

___ 12. prime number

___ 13. prism

___ 14. probability

___ 15. proportion

___ 16. protractor

___ 17. pyramid

___ 18. quadrilateral

___ 19. quotient

___ 20. radius

____ 21. range

___ 22. ratio

___ 23. ray

___ 24. rectangle

___ 25. regular polygon

___ 26. remainder

A. the distance around a closed figure

B. the number other than the remainder that is the result of dividing

C. a possible result of an experiment

D. a polygon whose sides are all equal and whose angles are all equal

E. a unit of measuring weight in the customary system

F. the number less than the divisor that remains after the division is complete

G. lines that lie in the same plane and do not intersect

H. a group of 3 digits in a number

I. a statement showing that two ratios are equal

J. per hundred, a way to compare a number to 100

K. a graph that uses symbols to show data

L. a quadrilateral with four right angles and opposite sides parallel and the same length

M. a solid figure whose bases lie in parallel planes and whose faces are parallelogram

N. the difference between the greatest and least numbers in a set of data

O. a quadrilateral with two pairs of opposite parallel sides

P. a solid figure whose base is a polygon and whose faces are triangles with a common vertex

Q. a figure made of five congruent squares joined edge to edge

R. an instrument used to measure the size of an angle

S. a pair of numbers used to compare quantities

T. two lines that form right angles where they intersect

U. part of a line that begins at a point and is endless in one direction

V. a closed plane figure made up of line segments

W. a line segment from the center of a circle to any point on the circle

X. a whole number greater than 1 that has only two factors, itself and 1

Y. the ratio of the number of ways an event can occur to the number of possible outcomes

Z. a polygon with four sides

NAME _____

DATE _____

Math Vocabulary Pretest 5

Match each word or words with its meaning.

___ 1. rhombus

___ 2. right angle

___ 3. right triangle

___ 4. sample

___ 5. scale

___ 6. scalene triangle

___ 7. similar polygons

___ 8. simplest form

___ 9. skew lines

___ 10. square

___ 11. standard form

___ 12. stem

___ 13. stem-and-leaf plot

___ 14. straight angle

___ 15. surface area

___ 16. ton

___ 17. trapezoid

___ 18. unit fraction

___ 19. variable

___ 20. vertex

___ 21. vertical axis

___ 22. word form

A. a quadrilateral that has exactly one pair of parallel sides

B. a representative part of a large group

C. a triangle that has one right angle

D. a quadrilateral that has four equal sides and four right angles

E. the point that two rays of an angle have in common, also a point where two or more edge meet

F. figures that have the same shape and may or may not have the same size

G. a way to show a number using words

H. a quadrilateral with two pairs of parallel sides and sides the same length

I. lines that are not parallel and do not intersect

J. the sum of the areas of all the faces of a solid

K. an angle that has a measure of 90°

L. the up-and-down number line on a graph

M. a triangle with no sides the same length

N. numbers that show the units used on a graph, also a ratio that shows the relationship between a scale drawing and the actual object

O. a letter that stands for a number or a range of numbers

P. a way to write a number that shows only its digits

Q. a graph for organizing data that, with 2-digit data, groups together all data with the same number of tens

R. a fraction with a numerator of 1

S. a fraction where the greatest common factor of the numerator and denominator is 1

T. the part of a stem-and-leaf plot that shows all but the last digit of a number

U. an angle that has a measure of 180°

V. a unit for measuring weight in the customary system

APPENDIX B

VOCABULARY LIST

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pint (pt)	458
quart (qt)	458
gallon (gal)	458
fluid ounce (fl oz)	459
teaspoon (tsp)	459
tablespoon (tbsp)	459

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APPENDIX C

MATHEMATICS ANXIETY SURVEY

How Do I Feel About Math?

Put a number from 1 to 5 next to each of these statements according to whether it is...

Almost never true, or you have little feeling about it = 1
Sometimes true, or you have some feeling about it = 2
Usually true, or you have a definite feeling about it = 3
Almost always true, or you have a strong feeling about it = 4
Always true, or you get a strong emotional reaction = 5

1. I feel an urge to play around, socialize, or stare out the window when math starts. ☐

2. When I meet students who love math or do it well, I either think they are a little weird or I envy them. ☐

3. If I am sitting with two students who are talking about math I have an urge to get out of there or do something else. ☐

4. When math starts I get a physical reaction in my body, like tightening, or tiring. ☐

5. Being asked to "go to the board" to explain a math idea in a class — even for math I am able to do at my desk — scares me. ☐

6. I'm not sure I can trust my answers, even on simple problems. ☐

7. I have a hard time sitting down to start math work outside school. ☐

8. Math never seems to stick, and after I learn it or get even a good grade on it, I still don't think I know it. ☐

9. When I'm around a hard math lesson or task, I feel

angry ☐ scared ☐ stupid ☐ tired ☐
helpless ☐ blank or fuzzy-brained ☐

10. In my body, challenging math problems give me:

upset stomach ☐ headache ☐

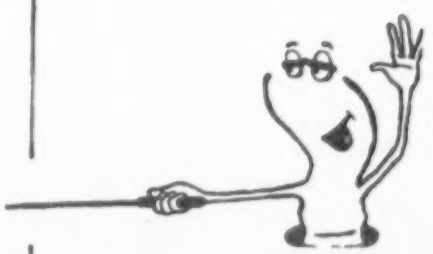
sweaty palms ☐ drowsiness ☐

Now add up all of the numbers you have written: _____

If you wrote no **5s and no more than one 4**, and you got **24 or less**, you probably feel fairly OK about math, but might need more practice or a little different instruction.

Otherwise here are your math anxiety estimates:

25-35 Some math discomfort and anxiety.
36-45 Quite a bit of fear and discomfort with math.
46-55 Very anxious about math. Talking about and working on this with your teacher and maybe with another adult you trust will help you a lot.
56-85 You are just about paralyzed by math! You have a lot you can gain from talking it over with your teacher and another adult you trust. It would also help to have your instruction or testing methods changed to make it easier for you to feel comfortable learning math.



APPENDIX D

TEACHER'S OBSERVATION CHECKLIST

Teacher's Observation Checklist

Date_____

Student	Proper Vocabulary Usage	Negative Verbal Cues	Positive Verbal Cues	Negative Nonverbal Cues	Positive Nonverbal Cues	Transfer of Ideas and Concepts	Miscellaneous	Scoring Rubric
A								3-definate positive cues (6 +)
B								2-some positive cues (3-5)
C								1-few positive cues (1-2)
D								0-no positive cues
E								
F								
G								
H								
I								
J								
K								
L								
M								
N								
O								
P								
Q								
R								
S								
T								
U								
V								
W								
X								

APPENDIX E

SAMPLES OF ARITHMETIC DONE DAILY (ADD)

ADD→5 Arithmetic Developed Daily

Name _____

① _____

_____

② _____

_____

③ _____

_____

184 x 23

687 + 921 + 51

6 + (4 x 4) =

6 x (4 + 4) =

6 ft. = _____ in.

5)520

Anya had $8.18 left after she bought lunch for $4.07, a magazine for $2.50 and new jeans for $14.25. How much did she start out with?

Thought _____

Information _____

Plan _____

Solution _____

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ADD→5 Arithmetic Developed Daily

Name _____

① _____

_____

② _____

_____

③ _____

_____

< > or =

.863 ◯ .763

.9 ◯ .89

27 x 68

5)760

4)7000

40,320 - 16,471

Carl earned $2.65 an hour helping a neighbor. How much did he earn for eight hours work?

Thought _____

Information _____

Plan _____

Solution _____

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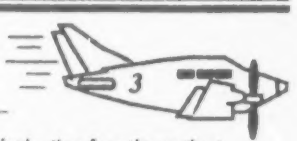

ADD→5 Arithmetic Developed Daily

Name _____

① ☐ 12

② _____ minutes

③ _____

_____

60 in. = _____ ft.

600 cm = _____ m

Round (to the nearest whole number)

5.43 _____ 17.7 _____

Circle the fractions that are the same as 1/2

$\frac{3}{6}$ $\frac{5}{8}$ $\frac{5}{10}$ $\frac{10}{25}$ $\frac{9}{18}$

A tractor company manufactured 21,343 tractors last year. Of these 2,125 were sold to Mexico. How many were left to sell?

Thought _____

Information _____

Plan _____

Solution 86

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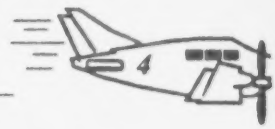
ADD→5 Arithmetic Developed Daily

Name _____



1. _____

$89.17
.65
+ 4.37

5 x 8 =

7 x 8 =

4 x 6 =

3 x 9 =

Order from greatest to least
20.63, 20.36, 26.03

_____ _____ _____

2. _____ _____ _____

3. _____ pints

Each section of the auditorium holds 108 people. How many people can be seated using all of the auditorium's three sections?

Thought _____

Information _____

Plan _____

Solution _____

©GRØW Publications

ADD→5 Arithmetic Developed Daily

Name _____

1. _____

Find the perimeter

5"

2" ☐

P = _____

5.4 - 3.7 =

6.8 - 4.2 =

$8\overline{)820}$

$4\overline{)\$4.24}$

2. _____

3. _____ cm

Mr. Daly spent the following amounts for groceries the last four weeks: $42.80, $56.92, $25.18 and $22.14. What was his average weekly grocery bill?

Thought _____

Information _____

Plan _____

Solution _____

©GRØW Publications

ADD→5 Arithmetic Developed Daily

Name _____

1. _____

$7\overline{)543}$

Write the numeral _____

Sixty-three and five ten-thousandths

$6.24
x 73

$\frac{1}{5}+\frac{3}{5}=$

$\frac{2}{9}+\frac{4}{9}=$

2. _____

3. _____

How many toasters worth $21 were purchased if the total bill for the toasters was $441?

Thought _____

Information _____

Plan _____

Solution 87

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#1 - Say to students

1 Find the answers to the following two problems: 210÷3, 6x500.

2 How many quarts are in a gallon?

3 Do the following chain of operations: 6, x2, -5, +7.

#2 - Say to students

1 Write the standard numeral for five hundred sixty-seven.

2 Write the number that follows nine hundred nine.

3 You buy an orange for $.49 and you give the clerk $1.00. How much change will you receive?

#3 - Say to students

1 Five-sixths (5/6) equals how many twelfths?

2 How many minutes are between 12:30 PM and 1:05 PM?

3 How many dozens are in 48 eggs?

#4 - Say to students

1 Do the following chain of operations: 80, -50, ÷2, -3.

2 I will say three numbers. Double each number and subtract 1: 5, 7, 3.

3 Three (3) quarts equal how many pints?

#5 - Say to students

1 What is 1/5 of 30?

2 What is 1/3 of a dozen?

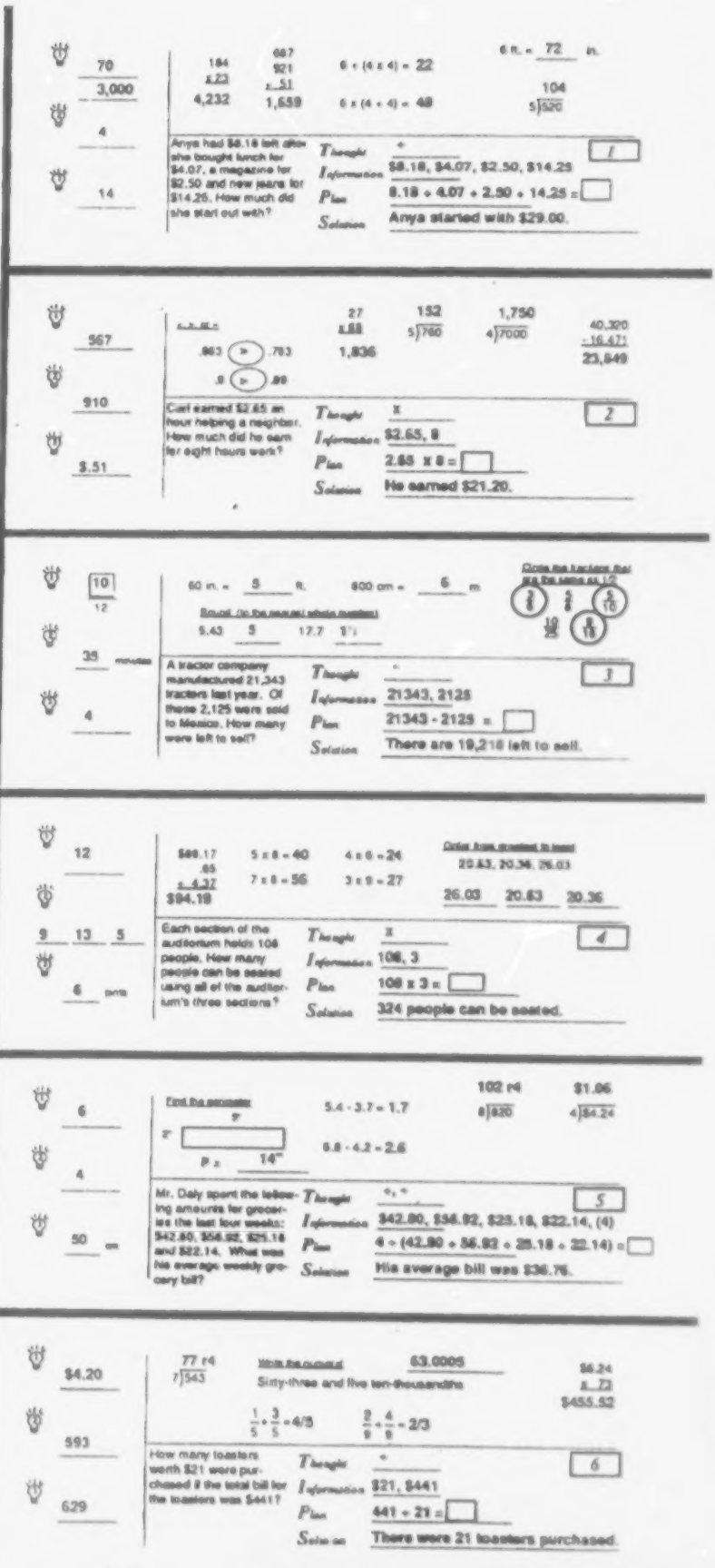
3 How many centimeters is 1/2 of a meter?

#6 - Say to students

1 You buy a candy bar for $.80 and give the clerk a $5.00 bill. How much change will you get back?

2 What is 563+30?

3 What is 429+200?



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APPENDIX F

VOCABULARY JOURNAL

NAME _____ **DATE** _____

Box 1-write the word
Box 2-write a definition for the word
Box 3-use the word in a sentence
Box 4-draw a picture or diagram that visually represents the meaning of the word

1.	2.
3.	4.

1.	2.
3.	4.

APPENDIX G

BINGO GAMEBOARD

AND

PIECES

VOCABULARY

B I N G O

		free space		

Chapter One	Chapter Two	Chapter 6	Chapter 10	Chapter 7	Chapter 8	Chapter 9
pictograph	cube	line	centimeter	fraction	least common denominator	unit fraction
bar graph	digit	ray	decimeter	numerator		factor
line plot	period	angle	meter	denominator equilvalent		
line graph	standard form	parallel lines	kilometer	fractions		
scale	expanded form	intersecting lines	millimeter	greatest common factor		
vertical axis	word form	perpendicular	perimeter	simplest form		
horizontal axis	exponent	end point	area	common denominator		
coordinates	number line	vertex	regular polygon	mixed numbers		
stem-and-leaf plot	equivalent decimals	protractor	height	improper fraction		
stem-and-leaf plot		degree	base	percent		
leaf		acute angle	diameter			
range		right angle	circumference			
mode		obtuse angle	chord			
median		straight angle	radius			
variable		polygon	pint			
		line segment	quart			
		equilateral triangle	gallon			
		isosceles triangle	fluid ounce			
		scalene triangle	teaspoon			
		right triangle	tablespoon			
		acute triangle				
		obtuse triangle				
		quadrilateral				
		square				
		rectangle				
		parallelogram				
		rhombus				

		trapezoid similar polygons congruent polygons pentomino line of symmetry				

Chapter 3	Chapter 4	Chapter 5
multiple	dividend	quotient
commutative property	division	algebraic expression
associative property	remainder	evaluate
benchmark numbers	divisor	
common multiple	quotient	
least common multiple	equation	
compatible numbers	mean	
	median	
	mode	
	factor	
	prime number	
	composite number	

APPENDIX H

SAMPLES OF PROBLEM OF THE DAY

Problem of the Day

Problem of the Day

A street parallel to Top Street is to be added. A traffic light will then be placed at each intersection. How many traffic lights are needed?

Possible answers:
5 lights or 7 lights

Problem of the Day

Problem of the Day

A floor is covered by 100 tiles in a 10 by 10 arrangement. How many tiles are not on the border?

64 tiles

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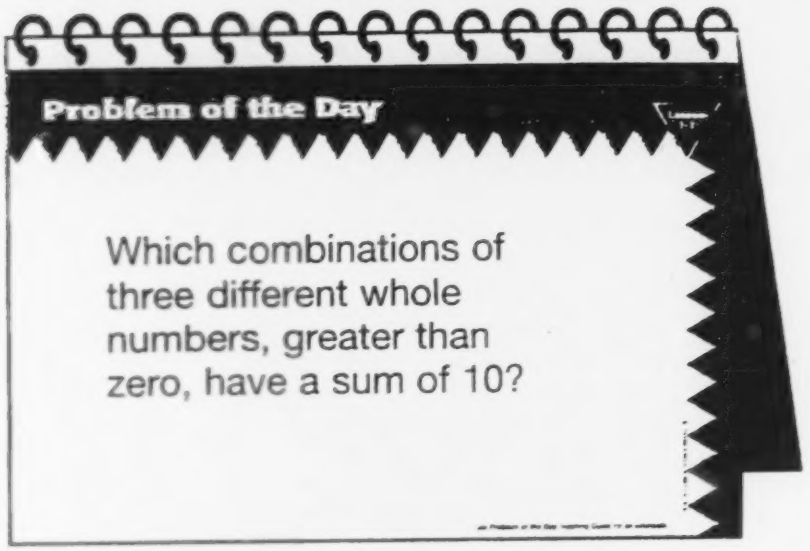
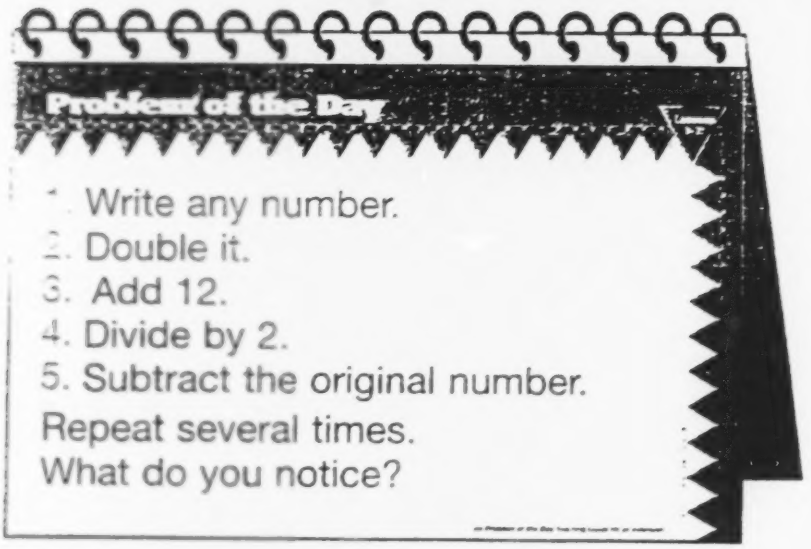
Problem of the Day



1, 2, 7; 1, 3, 6; 1, 4, 5; 2, 3, 5

Problem of the Day



The answer is always 6.

APPENDIX I

PROBLEM-SOLVING LOG

NAME_____ DATE_____

PROBLEM-SOLVING RESPONSE LOG

MATHEMATICAL KNOWLEDGE

ANSWER:

1 CORRECT
0 INCORRECT

STRATEGIC KNOWLEDGE

WHAT I DID:

4 FULL ACCOMPLISHMENT
3 SUBSTANTIAL ACCOMPLISHMENT
2 PARTIAL ACCOMPLISHMENT
1 LITTLE ACCOMPLISHMENT

EXPLANATION

WHY I DID IT:

4 FULL ACCOMPLISHMENT
3 SUBSTANTIAL ACCOMPLISHMENT
2 PARTIAL ACCOMPLISHMENT
1 LITTLE ACCOMPLISHMENT

COMMENTS:

APPENDIX J

PROBLEM-SOLVING LOG SCORING RUBRIC

PROBLEM-SOLVING RESPONSE SCORING

Mathematical Knowledge
1-Correct Answer
2-Incorrect Answer

Strategic Knowledge
4-Full Accomplishment
- Gives clear evidence of a complete and systematic solution process

3-Substantial Knowledge
- Solution process is nearly complete

2-Partial Knowledge
- Gives some evidence of a solution process

1-Little Knowledge
- Gives minimal evidence of a solution process: process may be difficult to identify

Explanation
4-Full Accomplishment
- Gives a complete written explanation; if a diagram is appropriate, there is a complete explanation of all the elements in the diagram

3-Substantial Accomplishment
- Gives a nearly complete written explanation of the solution process employed; may include a diagram with most of the elements explained

2-Partial Accomplishment
- Gives some explanation of the solution process; may include a diagram with some of the elements explained

1-Little Knowledge
- Provides minimal explanation of solution process; may fail to explain or may omit information; explanation does not match presented solution process